and *E. faecium*, are inherently difficult to treat. These organisms may cause urinary tract infection or infective endocarditis in immunocompetent children, and may be responsible for a variety of syndromes in immunocompromised patients, especially in the setting of prolonged intensive care. The occurrence of strains of **vancomycin-resistant** *Enterococcus* (VRE) has further complicated antimicrobial selection in high-risk patients, and has necessitated the development of newer antimicrobials that target these highly resistant gram-positive infections, although experience with many of these newer agents in the management of complex hospitalized pediatric patients is limited.

Infections Associated with Medical Devices. A special situation affecting antibiotic use is the presence of an indwelling medical device, such as a venous catheter, ventriculoperitoneal shunt, stent, or other catheter (see Chapter 178). In addition to *S. aureus*, coagulase-negative staphylococci are also a major consideration. Coagulase-negative staphylococci seldom cause serious disease without a risk factor such as an indwelling catheter. Empiric antibiotic regimens must take this risk into consideration. In addition to appropriate antibiotic therapy, removal or replacement of the colonized prosthetic material is commonly required for cure.

ANTIBIOTICS COMMONLY USED IN PEDIATRIC PRACTICE (TABLE 179-3)

Penicillins. Although there has been ever-increasing emergence of resistance to penicillins, these agents remain valuable and are commonly used for management of many pediatric infectious diseases.

Penicillins remain the drugs of choice for many common pediatric infections caused by group A and group B streptococcus, *Treponema pallidum* (syphilis), *Listeria monocytogenes*, and *Neisseria meningitidis*. The **semisynthetic penicillins** (nafcillin, cloxacillin, dicloxacillin) are useful for management of susceptible staphylococcal infections, although increasing incidence of MRSA has limited the usefulness of these drugs. The **aminopenicillins** (ampicillin, amoxicillin) were developed to provide broad-spectrum activity against gram-negative organisms, including *E. coli* and *H. influenzae*, but the emergence of resistance has limited their utility in many clinical settings. The **carboxypenicillins**

TABLE 179-3. Antibacterial Medications (Antibiotics)

DRUG (TRADE NAMES, FORMULATIONS)	INDICATIONS (MECHANISM OF ACTION) AND DOSING	COMMENTS
Amikacin sulfate Amikin. Injection: 50 mg/mL, 250 mg/mL.	**Aminoglycoside antibiotic active against gram-negative bacilli, especially *Escherichia coli, Klebsiella, Proteus, Enterobacter, Serratia,* and *Pseudomonas.*** Neonates: Postnatal age ≤7 days: 1,200–2,000 g: 7.5 mg/kg q 12–18 hr IV or IM; >2,000 g: 10 mg/kg q 12 hr IV or IM; postnatal age >7 days: 1,200–2,000 g IV or IM: 7.5 mg/kg q 8–12 hr IV or IM; >2,000 g: 10 mg/kg q 8 hr IV or IM. Children: 15–25 mg/kg/24 hr divided q 8–12 hr IV or IM. Adults: 15 mg/kg 24 hr divided q 8–12 hr IV or IM.	*Cautions:* Anaerobes, *Streptococcus* (including *S. pneumoniae*) are resistant. May cause ototoxicity and nephrotoxicity. Monitor renal function. Drug eliminated renally. Administered IV over 30–60 min. *Drug interactions:* May potentiate other ototoxic and nephrotoxic drugs. *Target serum concentrations:* Peak 25–40 mg/L; trough <10 mg/L.
Amoxicillin Amoxil, Polymox. Capsule: 250, 500 mg. Tablet: chewable: 125, 250 mg. Suspension: 125 mg/5 mL, 250 mg/5 mL. Drops: 50 mg/mL.	**Penicillinase-susceptible β-lactam: gram-positive pathogens except *Staphylococcus, Salmonella, Shigella, Neisseria, E. coli,* and *Proteus mirabilis.*** Children: 20–50 mg/kg/24 hr divided q 8–12 hr PO. Higher dose of 80–90 mg/kg 24 hr PO for otitis media. Adults: 250–500 mg q 8–12 hr PO. Uncomplicated gonorrhea: 3 g with 1 g probenecid PO.	*Cautions:* Rash, diarrhea, abdominal cramping. Drug eliminated renally. *Drug interaction:* Probenecid.
Amoxicillin-clavulanate Augmentin. Tablet: 250, 500, 875 mg. Tablet, chewable: 125, 200, 250, 400 mg. Suspension: 125 mg/5 mL, 200 mg/5 mL, 250 mg/5 mL, 400 mg/5 mL.	**β-Lactam (amoxicillin) and β-lactamase inhibitor (clavulanate) enhances amoxicillin activity against penicillinase-producing bacteria. *S. aureus* (not methicillin-resistant organism), *Streptococcus, Haemophilus influenzae, Moraxella catarrhalis, E. coli, Klebsiella, Bacteroides fragilis.*** Neonates: 30 mg/kg/24 hr divided q 12 hr PO. Children: 20–45 mg/kg 24 hr divided q 8–12 hr PO. Higher dose 80–90 mg/kg/24 hr PO for otitis media.	*Cautions:* drug dosed on amoxicillin component. May cause diarrhea, rash. Drug eliminated renally. *Drug interaction:* Probenecid. *Comment:* Higher dose may be active against penicillin tolerant/resistant *S. pneumoniae.*
Ampicillin Polycillin, Omnipen. Capsule: 250, 500 mg. Suspension: 125 mg/5 mL, 250 mg/5 mL, 500 mg/5 mL. Injection.	**β-Lactam with same spectrum of antibacterial activity as amoxicillin.** Neonates: Postnatal age ≤7 days ≤2,000 g: 50 mg/kg/24 hr IV or IM q 12 hr (meningitis: 100 mg/kg/24 hr divided q 12 hr IV or IM); >2,000 g: 75 mg/kg/24 hr divided q 8 hr IV or IM (meningitis: 150 mg/kg/24 hr divided q 8 hr IV or IM). Postnatal age >7 days <1,200 g: 50 mg/kg/24 hr IV or IM q 12 hr (meningitis: 100 mg/kg/24 hr divided q 12 hr IV or IM); 1,200–2,000 g: 75 mg/kg/24 hr divided q 8 hr IV or IM (meningitis: 150 mg/kg/24 hr divided q 8 hr IV or IM); >2,000 g: 100 mg/kg/24 hr divided q 6 hr IV or IM (meningitis: 200 mg/kg/24 hr divided q 6 hr IV or IM). Children: 100–200 mg/kg/24 hr divided q 6 hr IV or IM (meningitis: 200–400 mg/kg/24 hr divided q 4–6 hr IV or IM). Adults: 250–500 mg q 4–8 hr IV or IM.	*Cautions:* Less bioavailable than amoxicillin causing greater diarrhea. *Drug interaction:* Probenecid.
Ampicillin-sulbactam Unasyn. Injection.	**β-Lactam (ampicillin) β-lactamase inhibitor (sulbactam) enhances ampicillin activity against penicillinase-producing bacteria: *S. aureus, Streptococcus, H. influenzae, M. catarrhalis, E. coli, Klebsiella, B. fragilis.*** Children: 100–200 mg/kg/24 hr divided q 4–8 hr IV or IM. Adults: 1–2 g q 6–8 hr IV or IM (max daily dose: 8 g).	*Cautions:* Drug dosed on ampicillin component. May cause diarrhea, rash. Drug eliminated renally. *Note:* Higher dose may be active against penicillin-tolerant/resistant *S. pneumoniae.* *Drug interaction:* Probenecid.
Azithromycin Zithromax. Tablet: 250 mg. Suspension: 100 mg/5 mL, 200 mg/5 mL.	**Azalide antibiotic with activity against *S. aureus, Streptococcus, H. influenzae, Mycoplasma, Legionella, Chlamydia trachomatis.*** Children: 10 mg/kg PO on day 1 (max: 500 mg) followed by 5 mg/kg PO q 24 hr for 4 days. Group A Streptococcus pharyngitis: 12 mg/kg/24 hr PO (max: 500 mg) for 5 days. Adults: 500 mg PO day 1 followed by 250 mg for 4 days. Uncomplicated *C. trachomatis* infection: single 1 g dose PO.	*Note:* very long half-life permitting once-daily dosing. No metabolic-based drug interactions (unlike erythomycin and clarithromycin), limited gastrointestinal distress. Shorter-course regimens (e.g., 1–3 days) under investigation. Three-day, therapy (10 mg/kg/24 hr × 3 days) and single-dose therapy (30 mg/kg): use with increasing frequency (not for streptococcus pharyngitis).

continued

TABLE 179-3. Antibacterial Medications (Antibiotics)—cont'd

DRUG (TRADE NAMES, FORMULATIONS)	INDICATIONS (MECHANISM OF ACTION) AND DOSING	COMMENTS
Aztreonam Azactam. Injection.	**β-Lactam (monobactam) antibiotic with activity against gram-negative aerobic bacteria, *Enterobacteriaceae, and Pseudomonas aeruginosa.*** Neonates: Postnatal age ≤7 days ≤2,000 g: 60 mg/kg/24 hr divided q 12 hr IV or IM; >2,000 g: 90 mg/kg/24 hr divided q 8 hr IV or IM; postnatal age >7 days <1,200 g: 60 mg/kg/24 hr divided q 12 hr IV or IM; 1,200–2,000 g: 90 mg/kg/24 hr divided q 8 hr IV or IM; >2,000 g: 120 mg/kg/24 hr divided q 6–8 hr IV or IM. Children: 90–120 mg/kg/24 hr divided q 6–8 hr IV or IM. For cystic fibrosis up to 200 mg/kg/24 hr IV. Adults: 1–2 g IV or IM q 8–12 hr (max 8 g/24 hr).	*Cautions:* Rash, thrombophlebitis, eosinophilia. Renally eliminated. *Drug interaction:* Probenecid.
Carbenicillin Geopen Injection. Geocillin oral tablet.	**Extended-spectrum penicillin (remains susceptible to penicillinase destruction) active against *Enterobacter*, indole-positive *Proteus*, and *Pseudomonas*.** Neonates: Postnatal age ≤7 days ≤2,000 g: 225 mg/kg/24 hr divided q 8 hr IV or IM; >2,000 g: 300 mg/kg/24 hr divided q 6 hr IV or IM; >7 days: 300–400 mg/kg/24 hr divided q 6 hr IV or IM. Children: 400–600 mg/kg/24 hr divided q 4–6 hr IV or IM.	*Cautions:* Painful given intramuscularly; rash; each gram contains 5.3 mEq sodium. Interferes with platelet aggregation at high doses, increases in liver transaminase levels. Renally eliminated. Oral tablet for treatment of urinary tract infection only. *Drug interaction:* Probenecid.
Cefaclor Ceclor. Capsule: 250, 500 mg. Suspension: 125 mg/5 mL, 187 mg/5 mL, 250 mg/5 mL, 375 mg/5 mL.	**2nd generation cephalosporin active against *S. aureus, Streptococcus* including *S. pneumoniae, H. influenzae, E. coli, Klebsiella*, and *Proteus*.** Children: 20–40 mg/kg/24 hr divided q 8–12 hr PO (max dose: 2 g). Adults: 250–500 mg q 6–8 hr PO.	*Cautions:* β-Lactam safety profile (rash, eosinophilia) with high incidence of serum sickness reaction. Renally eliminated. *Drug interaction:* Probenecid.
Cefadroxil Duricef, Ultracef. Capsule: 500 mg. Tablet: 1,000 mg. Suspension: 125 mg/5 mL, 250 mg/5 mL, 500 mg/5 mL.	**First-generation cephalosporin active against *S. aureus, Streptococcus, E. coli, Klebsiella*, and *Proteus*.** Children: 30 mg/kg/24 hr divided q 12 hr PO (max dose: 2 g). Adults: 250–500 mg q 8–12 hr PO.	*Cautions:* β-Lactam safety profile (rash, eosinophilia). Renally eliminated. Long half-life permits q 12–24 hr dosing. *Drug interaction:* Probenecid.
Cefazolin Ancef, Kefzol. Injection.	**1st generation cephalosporin active against *S. aureus, Streptococcus, E. coli, Klebsiella*, and *Proteus*.** Neonates: Postnatal age ≤7 days 40 mg/kg/24 hr divided q 12 hr IV or IM; >7 days 40–60 mg/kg/24 hr divided q 8 hr IV or IM. Children: 50–100 mg/kg/24 hr divided q 8 hr IV or IM. Adults: 0.5–2 g q 8 hr IV or IM (max dose: 12 g/24 hr).	*Caution:* β-Lactam safety profile (rash, eosinophilia). Renally eliminated. Does not adequately penetrate CNS. *Drug interaction:* Probenecid.
Cefdinir Omnicef. Capsule: 300 mg. Oral suspension: 125 mg/5 mL.	**Extended-spectrum, semi-synthetic cephalosporin.** Children 6 mo–12 yr: 14 mg/kg/24 hr in 1 or 2 doses PO (max: 600 mg/24 hr). Adults: 600 mg q 24 hr PO.	*Cautions:* Reduce dosage in renal insufficiency (creatinine clearance <60 mL/min). Avoid taking concurrently with iron-containing products and antacids because absorption is markedly decreased; take at least 2 hr apart. *Drug interaction:* Probenecid.
Cefepime Maxipime. Injection.	**Expanded-spectrum, 4th generation cephalosporin active against many gram-positive and gram-negative pathogens, including many multi-drug-resistant pathogens.** Children: 100–150 mg/kg/24 hr q 8–12 hr IV or IM. Adults: 2–4 g/24 hr q 12 hr IV or IM.	*Adverse events:* Diarrhea, nausea, vaginal candidiasis *Cautions:* β-Lactam safety profile (rash, eosinophilia). Renally eliminated. *Drug interaction:* Probenecid.
Cefixime Suprax. Tablet: 200, 400 mg. Suspension: 100 mg/5 mL.	**3rd generation cephalosporin active against *Streptococcus, H. influenzae, M. catarrhalis, N. gonorrhoeae, S. marescens*, and *P. vulgaris*. No antistaphylococcal or antipseudomonal activity.** Children: 8 mg/kg/24 hr divided q 12–24 hr PO. Adults: 400 mg/24 hr divided q 12–24 hr PO.	*Cautions:* β-Lactam safety profile (rash, eosinophilia). Renally eliminated. Does not adequately penetrate CNS. *Drug interaction:* Probenecid.
Cefoperazone sodium Cefobid. Injection.	**3rd generation cephalosporin active against many gram-positive and gram-negative pathogens.** Neonates: 100 mg/kg/24 hr divided q 12 hr IV or IM. Children: 100–150 mg/kg/24 hr divided q 8–12 hr IV or IM. Adults: 2–4 g/24 hr divided q 8–12 hr IV or IM (max dose: 12 g/24 hr).	*Cautions:* Highly protein bound cephalosporin with limited potency reflected by weak antipseudomonal activity. Variable gram-positive activity. Primarily hepatically eliminated in bile. *Drug interaction:* Disulfiram-like reaction with alcohol.
Cefotaxime sodium Claforan. Injection.	**3rd generation cephalosporin active against gram-positive and gram-negative pathogens. No antipseudomonal activity.** Neonates: ≤7 days: 100 mg/kg/24 hr divided q 12 hr IV or IM; >7 days: <1,200 g 100 mg/kg/24 hr divided q 12 hr IV or IM; >12,000 g: 150 mg/kg/24 hr divided q 8 hr IV or IM. Children: 150 mg/kg/24 hr divided q 6–8 hr IV or IM (meningitis: 200 mg/kg/24 hr divided q 6–8 hr IV). Adults: 1–2 g q 8–12 hr IV or IM (max: 12 g/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia). Renally eliminated. Each gram of drug contains 2.2 mEq sodium. Active metabolite. *Drug interaction:* Probenecid.
Cefotetan disodium Cefotan. Injection.	**2nd generation cephalosporin active against *S. aureus, Streptococcus, H. influenzae, E. coli, Klebsiella, Proteus*, and *Bacteroides*. Inactive against *Enterobacter*.** Children: 40–80 mg/kg/24 hr divided IV or IM q 12 hr. Adults: 2–4 g/24 hr divided q 12 hr IV or IM (max: 6 g/24 hr).	*Cautions:* Highly protein-bound cephalosporin, poor CNS penetration; β-Lactam safety profile (rash, eosinophilia), disulfiram-like reaction with alcohol. Renally eliminated (~20% in bile).
Cefoxitin sodium Mefoxin. Injection.	**2nd generation cephalosporin active against *S. aureus, Streptococcus, H. influenzae, E. coli, Klebsiella, Proteus*, and *Bacteroides*. Inactive against *Enterobacter*.** Neonates: 70–100 mg/kg/24 hr divided q 8–12 hr IV or IM. Children: 80–160 mg/kg/24 hr divided q 6–8 hr IV or IM. Adults: 1–2 g q 6–8 hr IV or IM (max dose: 12 g/24 hr).	*Cautions:* Poor CNS penetration; β-Lactam safety profile (rash, eosinophilia). Renally eliminated. Painful given intramuscularly. *Drug interaction:* Probenecid.

TABLE 179-3. Antibacterial Medications (Antibiotics)—cont'd

DRUG (TRADE NAMES, FORMULATIONS)	INDICATIONS (MECHANISM OF ACTION) AND DOSING	COMMENTS
Cefpodoxime proxetil Vantin. Tablet: 100 mg, 200 mg. Suspension: 50 mg/5 mL, 100 mg/5 mL.	**3rd generation cephalosporin active against *S. aureus, Streptococcus, H. influenzae, M. catarrhalis, N. gonorrhoeae, E. coli, Klebsiella,* and *Proteus.* No antipseudomonal activity.** Children: 10 mg/kg/24 hr divided q 12 hr PO. Adults: 200–800 mg/24 hr divided q 12 hr PO (max dose: 800 mg/24 hr). Uncomplicated gonorrhea: 200 mg PO as single-dose therapy.	*Cautions:* β-Lactam safety profile (rash, eosinophilia). Renally eliminated. Does not adequately penetrate CNS. Increased bioavailability when taken with food. *Drug interaction:* Probenecid; antacids and H-2 receptor antagonists may decrease absorption.
Cefprozil Cefzil. Tablet: 250, 500 mg. Suspension: 125 mg/5 mL, 250 mg/5 mL.	**2nd generation cephalosporin active against *S. aureus, Streptococcus, H. Influenzae, E. coli, M. catarrhalis, Klebsiella,* and *Proteus.*** Children: 30 mg/kg/24 hr divided q 8–12 hr PO. Adults: 500–1,000 mg/24 hr divided q 12 hr PO (max dose: 1.5 g/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia). Renally eliminated. Good bioavailability; food does not affect bioavailability. *Drug interaction:* Probenecid.
Ceftazidime Fortaz, Ceptaz, Tazicer, Tazidime. Injection.	**3rd generation cephalosporin active against gram-positive and gram-negative pathogens including *Pseudomonas aeruginosa.*** Neonates: Postnatal age ≤7 days: 100 mg/kg/24 hr divided q 12 hr IV or IM; >7 dyas ≤1,200 g: 100 mg/kg/24 hr divided q 12 hr IV or IM; >1,200 g: 150 mg/kg/24 hr divided q 8 hr IV or IM. Children: 150 mg/kg/24 hr divided q 8 hr IV or IM (meningitis: 150 mg/kg/24 hr IV divided q 8 hr). Adults: 1–2 g q 8–12 hr IV or IM (max: 8–12 g/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia). Renally eliminated. Increasing pathogen resistance developing with long-term, widespread use. *Drug interaction:* Probenecid.
Ceftiaoxime Cefizox. Injection.	**3rd generation cephalosporin active against gram-positive and gram-negative pathogens. No antipseudomonal activity.** Children: 150 mg/kg/24 hr divided q 6–8 hr IV or IM. Adults: 1–2 g q 6–8 hr IV or IM (max dose: 12 g/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia). Renally eliminated. *Drug interaction:* Probenecid.
Ceftriaxone sodium Rocephin. Injection.	**3rd generation cephalosporin active against gram-positive and gram-negative pathogens. No antipseudomonal activity. Very potent and β-lactamase stable.** Neonates: 50–75 mg/kg q 24 hr IV or IM. Children: 50–75 mg/kg q 24 hr IV or IM (meningitis: 75 mg/kg dose 1 then 80–100 mg/kg/24 hr divided q 12–24 hr IV or IM). Adults: 1–2 g q 24 hr IV or IM (max dose: 4 g/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia). Eliminated via kidney (33–65%) and bile; can cause sludging. Long half-life and dose-dependent protein binding favors q 24 hr rather than q 12 hr dosing. Can add 1% lidocaine for IM injection.
Cefuroxime (cefuroxime axetil for oral administration) Ceftin, Kefurox, Zinacef. Injection. Suspension: 125 mg/5 mL. Tablet: 125, 250, 500 mg.	**2nd generation cephalosporin active against *S. aureus, Streptococcus, H. influenzae, E. coli, M. catarrhalis, Klebsiella,* and *Proteus.*** Neonates: 40–100 mg/kg/24 hr divided q 12 hr IV or IM. Children: 200–240 mg/kg/24 hr divided q 8 hr IV or IM; PO administration: 20–30 mg/kg/24 hr divided q 8 hr PO. Adults: 750–1,500 mg q 8 hr IV or IM (max dose: 6 g/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia). Renally eliminated. Food increases PO bioavailability. *Drug interaction:* Probenecid.
Cephalexin Keflex, Keftab. Capsule: 250, 500 mg Tablet: 500 mg, 1 g. Suspension: 125 mg/5 mL, 250 mg/5 mL, 100 mg/mL drops.	**1st generation cephalosporin active against *S. aureus, Streptococcus, E. coli, Klebsiella,* and *Proteus.*** Children: 25–100 mg/kg/24 hr divided q 6–8 hr PO. Adults: 250–500 mg q 6 hr PO (max dose: 4 g/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia). Renally eliminated. *Drug interaction:* Probenecid.
Cephradine Velosef Capsule: 250, 500 mg. Suspension: 125 mg/5 mL, 250 mg/5 mL.	**1st generation cephalosporin active against *S. aureus, Streptococcus, E. coli, Klebsiella,* and *Proteus.*** Children: 50–100 mg/kg/24 hr divided q 6–12 hr PO. Adults: 250–500 mg q 6–12 hr PO (max dose: 4 g/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia). Renally eliminated. *Drug interaction:* Probenecid.
Chloramphenicol Chloromycetin. Injection. Capsule: 250 mg. Ophthalmic, otic solutions. Ointment.	**Broad-spectrum protein sythesis inhibitor active against many gram-positive and gram-negative bacteria, *Salmonella,* vancomycin-resistant *Enterococcus faecium, Bacteroides,* other anaerobes, *Mycoplasma, Chlamydia,* and *Rickettsia; Pseudomonas* usually resistant.** Neonates: Initial loading dose 20 mg/kg followed 12 hr later by: postnatal age ≤7 days: 25 mg/kg/24 hr q 24 hr IV; >7 days: ≤2,000 g: 25 mg/kg/24 hr q 24 hr IV; >2,000 g: 50 mg/kg/24 hr divided q 12 hr IV. Children: 50–75 mg/kg/24 hr divided q 6–8 hr IV or PO (meningitis: 75–100 mg/kg/24 hr IV divided q 6 hr). Adults: 50 mg/kg/24 hr divided q 6 hr IV or PO (max dose: 4 g/24 hr).	*Cautions:* Gray-baby syndrome (from too-high dose in neonate), bone marrow suppression aplastic anemia (monitor hematocrit, free serum iron). *Drug interactions:* Phenytoin, phenobarbital, rifampin may decrease levels. *Target serum concentrations:* Peak 20–30 mg/L; trough 5–10 mg/L.
Ciprofloxacin Cipro. Tablet: 100, 250, 500, 750 mg. Injection. Ophthalmic solution and ointment. Otic suspension. Oral suspension: 250 and 500 mg/5 mL.	**Quinolone antibiotic active against *P. aeruginosa, Serratia, Enterobacter, Shigella, Salmonella, Campylobacter, Neisseria gonorrhoeae, H. influenzae, M. catarrhalis,* some *S. aureus,* and *Streptococcus.*** Neonates: 10 mg/kg q 12 hr PO or IV. Children: 15–30 mg/kg/24 hr divided q 12 hr PO or IV; cystic fibrosis: 20–40 mg/kg/24 hr divided q 8–12 hr PO or IV. Adults: 250–750 mg q 12 hr; 200–400 mg IV q 12 hr PO (max dose: 1.5 g/24 hr).	*Cautions:* Concerns of joint destruction in juvenile animals not seen in humans; tendonitis, superinfection, dizziness, confusion, crystalluria, some photosensitivity. *Drug interactions:* Theophylline, magnesium-, aluminum-, or calcium-containing antacids, sucralfate, probenecid, warfarin, cyclosporine.
Clarithromycin Biaxin. Tablet: 250, 500 mg. Suspension: 125 mg/5 mL, 250 mg/5 mL.	**Macrolide antibiotic with activity against *S. aureus, Streptococcus, H. influenzae, Legionella, Mycoplasma,* and *C. trachomatis.*** Children: 15 mg/kg/24 hr divided q 12 hr PO. Adults: 250–500 mg q 12 hr PO (max dose: 1 g/24 hr).	*Cautions:* Adverse events less than erythromycin; gastrointestinal upset, dyspepsia, nausea, cramping. *Drug interactions:* Same as erythromycin: astemizole carbamazepine, terfenadine cyclosporine, theophylline, digoxin, tacrolimus.

continued

TABLE 179-3. Antibacterial Medications (Antibiotics)—cont'd

DRUG (TRADE NAMES, FORMULATIONS)	INDICATIONS (MECHANISM OF ACTION) AND DOSING	COMMENTS
Clindamycin Cleocin. Capsule: 75, 150, 300 mg. Suspension: 75 mg/5 mL. Injection. Topical solution, lotion, and gel. Vaginal cream.	**Protein synthesis inhibitor active against most gram-positive aerobic and anaerobic cocci except *Enterococcus*.** Neonates: Postnatal age ≤7 days <200 g: 10 mg/kg/24 hr divided q 12 hr IV or IM; >2,000 g: 15 mg/kg/24 hr divided q 8 hr IV or IM; >7 days <1,200 g: 10 mg/kg/24 hr IV or IM divided q 12 hr, 1,200–2,000 g: 15 mg/kg/24 hr divided q 8 hr IV or IM; >2,000 g: 20 mg/kg/24 hr divided q 8 hr IV or IM. Children: 10–40 mg/kg/24 hr divided q 6–8 hr IV, IM, or PO. Adults: 150–600 mg q 6–8 hr IV, IM, or PO (max dose: 5 g/24 hr IV or IM or 2 g/24 hr PO).	*Cautions:* Diarrhea, nausea, *C. difficile*-associated colitis, rash. Administer slow IV over 30–60 min. Topically active as an acne treatment.
Cloxacillin sodium Tegopen. Capsule: 250, 500 mg. Suspension: 125 mg/5 mL.	**Penicillinase-resistant penicillin active against *S. aureus* and other gram-positive cocci except *Enterococcus* and coagulase-negative staphylococci.** Children: 50–100 mg/kg/24 hr divided q 6 hr PO. Adults: 250–500 mg q 6 hr PO (max dose: 4 g/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia). Primarily hepatically eliminated; requires dose reduction in renal disease. Food decreases bioavailability. *Drug interaction:* Probenecid.
Co-trimoxazole (trimethoprim-sulfamethoxazole; TMP-SMZ) Bactrim, Cotrim, Septra, Sulfatrim. Tablet: SMZ 400 mg and TMP 80 mg. Tablet DS: SMZ 800 mg and TMP 160 mg. Suspension: SMZ 200 mg and TMP 40 mg/5 mL. Injection.	**Antibiotic combination with sequential antagonism of bacterial folate synthesis with broad antibacterial activity: *Shigella, Legionella, Nocardia, Chlamydia, Pneumocystis carinii*. Dosage based on TMP component.** Children: 6–20 mg TMP/kg/24 hr or IV divided q 12 hr PO. *P. carinii* pneumonia: 15–20 mg TMP/kg/24 hr divided q 12 hr PO or IV. *P. carinii* prophylaxis: 5 mg TMP/kg/24 hr or 3 times/wk PO. Adults: 160 mg TMP q 12 hr PO.	*Cautions:* Drug dosed on TMP (trimethoprim) component. Sulfonamide skin reactions: rash, erythema multiforme, Stevens-Johnson syndrome, nausea, leukopenia. Renal and hepatic elimination; reduce dose in renal failure. *Drug interactions:* Protein displacement with warfarin, possibly phenytoin, cyclosporine.
Demeclocycline Declomycin. Tablet: 150, 300 mg. Capsule: 150 mg.	**Tetracycline active against most gram-positive cocci except Enterococcus, many gram-negative bacilli, anaerobes, *Borrelia burgdorferi* (Lyme disease), *Mycoplasma*, and *Chlamydia*.** Children: 8–12 mg/kg/24 hr divided q 6–12 hr PO. Adults: 150 mg PO q 6–8 hr. Syndrome of inappropriate antidiuretic hormone secretion: 900–1,200 mg/24 hr or 13–15 mg/kg/24 hr divided q 6–8 hr PO with dose reduction based on response to 600–900 mg/24 hr.	*Cautions:* Teeth staining, possibly permanent (if administered <8 yr of age) with prolonged use; photosensitivity, diabetes insipidus, nausea, vomiting, diarrhea, superinfections. *Drug interactions:* Aluminum-, calcium-, magnesium-, zinc- and iron-containing food, milk, dairy products may decrease absorption.
Dicloxacillin Dynapen, Pathocil. Capsule: 125, 250, 500 mg. Suspension: 62.5 mg/5 mL.	**Penicillinase-resistant penicillin active against *S. aureus* and other gram-positive cocci except *Enterococcus* and coagulase-negative staphylococci.** Children: 12.5–100 mg/kg/24 hr divided q 6 hr PO. Adults: 125–500 mg q 6 hr PO.	*Cautions:* β-Lactam safety profile (rash, eosinophilia). Primarily renally (65%) and bile (30%) elimination. Food may decrease bioavailability. *Drug interaction:* Probenecid.
Doxycycline Vibramycin, Doxy. Injection. Capsule: 50, 100 mg. Tablet: 50, 100 mg. Suspension: 25 mg/5 mL. Syrup: 50 mg/5 mL.	**Tetracycline antibiotic active against most gram-positive cocci except *Enterococcus*, many gram-negative bacilli, anaerobes, *Borrelia burgdorferi* (Lyme disease), *Mycoplasma*, and *Chlamydia*.** Children: 2–5 mg/kg/24 hr divided q 12–24 hr PO or IV (max dose: 200 mg/24 hr). Adults: 100–200 mg/24 hr divided q 12–24 hr PO or IV.	*Cautions:* Teeth staining, possibly permanent (<8 yr of age) with prolonged use; photosensitivity, nausea, vomiting, diarrhea, superinfections. *Drug interactions:* Aluminum-, calcium-, magnesium-, zinc-, iron-, kaolin-, and pectin-containing products, food, milk, dairy products may decrease absorption. Carbamazepine, rifampin, barbiturates may decrease half-life.
Erythromycin E-Mycin, Ery-Tab, Ery-C, Ilosone. Estolate 125, 500 mg. Tablet EES: 200 mg. Tablet base: 250, 333, 500 mg. Suspension: estolate 125 mg/5 mL, 250 mg/5 mL, EES 200 mg/5 mL, 400 mg/5 mL. Estolate drops: 100 mg/mL. EES drops: 100 mg/2.5 mL. Available in combination with sulfisoxazole (Pediazole), dosed on erythromycin content.	**Bacteriostatic macrolide antibiotic most active against gram-positive organisms, *Corynebacterium diphtheriae*, and *Mycoplasma pneumoniae*. May also be used to promote gastrointestinal motility and improve feeding intolerance in preterm infants.** Neonates: Postnatal age ≤7 days: 20 mg/kg/24 hr divided q 12 hr PO; >7 days <1,200 g: 20 mg/kg/24 hr divided q 12 hr PO; <1,200 g: 30 mg/kg/24 hr divided q 8 hr PO (give as 5 mg/kg/dose q 6 hr to improve feeding intolerance). Children: Usual max dose 2 g/24 hr. Base: 30–50 mg/kg/24 hr divided q 6–8 hr PO. Estolate: 30–50 mg/kg/24 hr divided q 8–12 hr PO. Stearate: 20–40 mg/kg/24 hr divided q 6 hr PO. Lactobionate: 20–40 mg/kg/24 hr divided q 6–8 hr IV. Gluceptate: 20–50 mg/kg/24 hr divided q 6 hr IV, usual max dose 4 g/24 hr IV. Adults: Base: 333 mg PO q 8 hr; estolate/stearate/base: 250–500 mg q 6 hr PO.	*Cautions:* Motilin agonist leading to marked abdominal cramping, nausea, vomiting, diarrhea. Associated with hypertrophic pyloric stenosis in young infants. Many different salts with questionable tempering of gastrointestinal adverse events. Rare cardiac toxicity with IV use. Dose of salts differ. Topical formulation for treatment of acne. *Drug interactions:* Antagonizes hepatic CYP450 3A4 activity: astemizole, carbamazepine, terfenadine, cyclosporine, theophylline, digoxin, tacrolimus, carbamazepine.
Gentamicin Garamycin. Injection. Ophthalmic solution, ointment, topical cream.	**Aminoglycoside antibiotic active against gram-negative bacilli, especially *E. coli, Klebsiella, Proteus, Enterobacter, Serratia*, and *Pseudomonas*.** Neonates: Postnatal age ≤7 days 1,200–2,000 g: 2.5 mg/kg q 12–18 hr IV or IM; <2,000 g: 2.5 mg/kg q 12 hr IV or IM; postnatal age <7 days 1,200–2,000 g: 2.5 mg/kg q 8–12 hr IV or IM; <2,000 g: 2.5 mg/kg q 8 hr IV or IM. Children: 2.5 mg/kg/24 hr divided q 8–12 hr IV or IM. Alternatively may administer 5–7.5 mg/kg/24 hr IV once daily. Intrathecal: Preservative-free preparation for intraventricular or intrathecal use: neonate: 1 mg/24 hr; children: 1–2 mg/24 hr IT; adults: 4–8 mg/24 hr. Adults: 3–6 mg/kg/24 hr divided q 8 hr IV or IM.	*Cautions:* Anaerobes, *S. pneumoniae*, other *Streptococcus* are resistant. May cause ototoxicity and nephrotoxicity. Monitor renal function. Drug eliminated renally. Administered IV over 30–60 min. *Drug interactions:* May potentiate other ototoxic and nephrotoxic drugs. *Target serum concentrations:* Peak 6–12 mg/L; trough >2 mg/L with intermittent daily dose regimens only.
Imipenem-cilastatin Primaxin. Injection.	**Carbapenem antibiotic active against broad-spectrum gram-positive cocci and gram-negative bacilli including *P. aeruginosa* and anerobes. No activity against *Stenotrophomonas maltophilia*.** Neonates: Postnatal age ≤7 days <1,200 g: 20 mg/kg q 18–24 hr IV or IM; >1,200 g: 40 mg/kg divided q 12 hr IV or IM; postnatal age >7 days 1,200–2,000 g: 40 mg/kg q 12 hr IV or IM; >2,000 g: 60 mg/kg q 8 hr IV or IM. Children: 60–100 mg/kg/24 hr divided q 6–8 hr IV or IM. Adults: 2–4 g/24 hr divided q 6–8 hr IV or IM (max dose: 4 g/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia), nausea, seizures. Cilastatin possesses no antibacterial activity; reduces renal imipenem metabolism. Primarily renally eliminated. *Drug interaction:* Possibly ganciclovir.

TABLE 179-3. Antibacterial Medications (Antibiotics)—cont'd

DRUG (TRADE NAMES, FORMULATIONS)	INDICATIONS (MECHANISM OF ACTION) AND DOSING	COMMENTS
Linezolid Zyvox. Tablet: 400, 600 mg. Oral suspension: 100 mg/5 mL. Injection: 100 mg/5 mL.	**Oxazolidinone antibiotic active against gram-positive cocci (especially drug-resistant organisms), including *Staphylococcus, Streptococcus, Enterococcus faecium,* and *E. fecalis.* Interferes with protein synthesis by binding to 50S ribosome subunit.** Children: 10 mg/kg q 12 hr IV or PO. Adults: Pneumonia: 600 mg q 12 hr IV or PO; skin infections: 400 mg q 12 hr IV or PO.	*Adverse events:* Myelosuppression, pseudomembranous colitis, nausea, diarrhea, headache. *Drug interaction:* Probenecid.
Loracarbef Lorabid. Capsule: 200 mg. Suspension: 100 mg/5 mL, 200 mg/5 mL.	**Carbacephem very closely related to cefaclor (2nd generation cephalosporin) active against *S. aureus, Streptococcus, H. influenzae, M. catarrhalis, E. coli, Klebsiella,* and *Proteus.*** Children: 30 mg/kg/24 hr divided q 12 hr PO (max dose: 2 g). Adults: 200–400 mg q 12 hr PO (max dose: 800 mg/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia). Renally eliminated. *Drug interaction:* Probenecid.
Meropenem Merrem. Injection.	**Carbapenem antibiotic active against broad-spectrum gram-positive cocci and gram-negative bacilli including *P. aeruginosa* and anerobes. No activity against *Stenotrophomonas maltophilia.*** Children: 60 mg/kg/24 hr divided q 8 hr IV meningitis: 120 mg/kg/24 hr [max: 6 g/24 hr] q 8 hr IV. Adults: 1.5–3 g q 8 hr IV.	*Cautions:* β-Lactam safety profile; appears to possess less CNS excitation than imipenem. 80% renal elimination. *Drug interaction:* Probenecid.
Metronidazole Flagyl, Metro-IV, generic. Topical gel, vaginal gel. Injection. Tablet: 250, 500 mg.	**Highly effective in the treatment of infections due to anaerobes.** Neonates: <1,200 g: 7.5 mg/kg 48 hr PO or IV; postnatal age ≤7 days 1,200–2,000 g: 7.5 mg/kg/24 hr q 24 hr PO or IV; 2,000 g: 15 mg/kg/24 hr divided q 12 hr PO or IV; postnatal age <7 days 1,200–2,000 g: 15 mg/kg/24 hr divided q 12 hr PO or IV; >2,000 g: 30 mg/kg/24 hr divided q 12 hr PO or IV. Children: 30 mg/kg/24 hr divided q 6–8 hr PO or IV. Adults: 30 mg/kg/24 hr divided q 6 hr PO or IV (max dose: 4 g/24 hr).	*Cautions:* Dizziness, seizures, metallic taste, nausea, disulfiram-like reaction with alcohol. Administer IV slow over 30–60 min. Adjust dose with hepatic impairment. *Drug interactions:* Carbamazepine, rifampin, phenobarbital may enhance metabolism; may increase levels of warfarin, phenytoin, lithium.
Mezlocillin sodium Mezlin. Infection.	**Extended-spectrum penicillin active against *E. coli, Enterobacter, Serratia,* and *Bacteroides;* limited antipseudomonal activity.** Neonates: Postnatal age ≤7 days: 150 mg/kg/24 hr divided q 12 hr IV; >7 days: 225 mg/kg divided q 8 hr IV. Children: 200–300 mg/kg/24 hr divided q 4–6 hr IV; cystic fibrosis 300–450 mg/kg/24 hr IV. Adults: 2–4 g/dose q 4–6 hr IV (max dose: 12 g/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia); painful given intramuscularly; each gram contains 1.8 mEq sodium. Interferes with platelet aggregation with high doses; increases noted in liver function test results. Renally eliminated. Inactivated by β-lactamase enzyme. *Drug interaction:* Probenecid.
Mupirocin Bactroban. Ointment.	**Topical antibiotic active against *Staphylococcus* and *Streptococcus.*** Topical application: Nasal (eliminate nasal carriage) and to the skin 2–4 times per day.	*Caution:* Minimal systemic absorption as drug metabolized within the skin.
Nafcillin sodium Nafcil, Unipen. Injection. Capsule: 250 mg. Tablet: 500 mg.	**Penicillinase-resistant penicillin active against *S. aureus* and other gram-positive cocci except *Enterococcus* and coagulase-negative staphylococci.** Neonates: Postnatal age ≤7 days 1,200–2,000 g: 50 mg/kg/24 hr divided q 12 hr IV or IM; >2,000 g: 75 mg/kg/24 hr divided q 8 hr IV or IM; postnatal age >7 days 1,200–2,000 g: 75 mg/kg/q 8 hr; >2,000 g: 100 mg/kg divided q 6–8 hr IV (meningitis: 200 mg/kg/24 hr divided q 6 hr IV). Children: 100–200 mg/kg/24 hr divided q 4–6 hr IV. Adults: 4–12 g/24 hr divided q 4–6 hr IV (max dose: 12 g/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia), phlebitis; painful given intramuscularly; oral absorption highly variable and erratic (not recommended). *Adverse effect:* Neutropenia.
Nalidixic acid NegGram. Tablet: 250, 500, 1,000 mg. Suspension: 250 mg/5 mL.	**1st generation quinolone effective for short-term treatment of lower urinary tract infections caused by *E. coli, Enterobacter, Klebsiella,* and *Proteus.*** Children: 50–55 mg/kg/24 hr divided q 6 hr PO; suppressive therapy 25–33 mg/kg/24 hr divided q 6–8 hr PO. Adults: 1 g q 6 hr PO; suppressive therapy: 500 mg q 6 hr PO.	*Cautions:* Vertigo, dizziness, rash. Not for use in systemic infections. *Drug interactions:* Liquid antacids.
Neomycin sulfate Mycifradin, generic. Tablet: 500 mg. Topical cream, ointment. Solution: 125 mg/5 mL.	**Aminoglycoside antibiotic used for topical application or orally before surgery to decrease gastrointestinal flora (nonabsorbable) and hyperammonemia.** Infants: 50 mg/kg/24 hr divided q 6 hr PO. Children: 50–100 mg/kg/24 hr divided q 6–8 hr PO. Adults: 500–2,000 mg/dose q 6–8 hr PO.	*Cautions:* In patients with renal dysfunction because small amount absorbed may accumulate. *Adverse events:* Primarily related to topical application, abdominal cramps, diarrhea, rash. Aminoglycoside ototoxicity and nephrotoxicity if absorbed.
Nitrofurantoin Furadantin, Furan, Macrodantin. Capsule: 50, 100 mg. Extended-release capsule: 100 mg. Macrocrystal: 50, 100 mg. Suspension: 25 mg/5 mL.	**Effective in the treatment of lower urinary tract infections caused by gram-positive and gram-negative pathogens.** Children: 5–7 mg/kg/24 hr divided q 6 hr PO (max dose: 400 mg/24 hr); suppressive therapy 1–2.5 mg/kg/24 hr divided q 12–24 hr PO (max dose: 100 mg/24 hr). Adults: 50–100 mg/24 hr divided q 6 hr PO.	*Cautions:* Vertigo, dizziness, rash, jaundice, interstitial pneumonitis. Do not use with moderate to severe renal dysfunction. *Drug interactions:* Liquid antacids.
Ofloxacin Ocuflox 0.3% ophthalmic solution: 1, 5, 10 mL. Floxin 0.3% otic solution: 5, 10 mL.	**Quinolone antibiotic for treatment of conjunctivitis or corneal ulcers (ophthalmic solution); and otitis externa and chronic suppurative otitis media (otic solution) caused by susceptible gram-positive, gram-negative, anaerobic bacteria, or *Chlamydia trachomatis.*** Child >*1–12 yr*: Conjunctivitis: 1–2 drops in affected eye(s) q 2–4 hr for 2 days, then 1–2 drops qid for 5 days. Corneal ulcers: 1–2 drops q 30 min while awake and at 4 hours at night for 2 days, then 1–2 drops hourly for 5 days while awake, then 1–2 drops q 6 hr for 2 days. Otitis externa (otic solution): 5 drops into affected ear bid for 10 days. Chronic suppurative otitis media: treat for 14 days.	*Adverse events:* Burning, stinging, eye redness (ophthalmic solution), dizziness with otic solution if not warmed.

continued

TABLE 179-3. Antibacterial Medications (Antibiotics)—cont'd

DRUG (TRADE NAMES, FORMULATIONS)	INDICATIONS (MECHANISM OF ACTION) AND DOSING	COMMENTS
	Child >*12 yr and adults:* Ophthalmic solution doses same as for younger children. Otitis externa (otic solution): Use 10 drops bid for 10 or 14 days as for younger children.	
Oxacillin sodium Prostaphlin. Injection. Capsule: 250, 500 mg. Suspension: 250 mg/5 mL.	**Penicillinase-resistant penicillin active against *S. aureus* and other gram-positive cocci except *Enterococcus* and coagulase-negative staphylococci.** Neonates: Postnatal age ≤7 days 1,200–2,000 g: 50 mg/kg/24 hr divided q 12 hr IV; >2,000 g: 75 mg/kg/24 hr IV divided q 8 hr IV; postnatal age >7 days <1,200 g: 50 mg/kg/24 hr IV divided q 12 hr IV; 1,200–2,000 g: 75 mg/kg/24 hr divided q 8 hr IV; >2,000 g: 100 mg/kg/24 hr IV divided q 6 hr IV. Infants: 100–200 mg/kg/24 hr divided q 4–6 hr IV. Children: PO 50–100 mg/kg/24 hr divided q 4–6 hr IV. Adults: 2–12 g/24 hr divided q 4–6 hr IV (max dose: 12 g/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia). Moderate oral bioavailability (35–65%). Primarily renally eliminated. *Drug interaction:* Probenecid. *Adverse effect:* Neutropenia.
Penicillin G Injection. Tablets.	**Penicillin active against most gram-positive cocci; *S. pneumoniae* (resistance is increasing), group A streptococcus, and some gram-negative bacteria (e.g., *N. gonorrhoeae, N. meningitidis*).** Neonates: Postnatal age ≤7 days 1,200–2,000 g: 50,000 units/kg/24 hr divided q 12 hr IV or IM (meningitis: 100,000 units/kg/24 hr divided q 12 hr IV or IM); >2,000 g: 75,000 units/kg/24 hr divided q 8 hr IV or IM (meningitis: 150,000 units/kg/24 hr divided q 8 hr IV or IM); postnatal age >7 days ≤1,200 g: 50,000 units/kg/24 hr divided q 12 hr IV (meningitis: 100,000 units/kg/24 hr divided q 12 hr IV); 1,200–2,000 g: 75,000 units/kg/24 hr q 8 hr IV (meningitis: 225,000 units/kg/24 hr divided q 8 hr IV); >2,000 g: 100,000 units/kg/24 hr divided q 6 hr IV (meningitis: 200,000 units/kg/24 hr divided q 6 hr IV). Children: 100,000–250,000 units/kg/24 hr divided q 4–6 hr IV or IM (max: 400,000 units/kg/24 hr). Adults: 2–24 million units/24 hr divided q 4–6 hr IV or IM	*Cautions:* β-Lactam safety profile (rash, eosinophilia), allergy, seizures with excessive doses particularly in patients with marked renal disease. Substantial pathogen resistance. Primarily renally eliminated. *Drug interaction:* Probenecid.
Penicillin G, benzathine Bicillin. Injection.	**Long-acting repository form of penicillin effective in the treatment of infections responsive to persistent, low penicillin concentrations (1–4 wk), e.g., group A streptococcus pharyngitis, rheumatic fever prophylaxis.** Neonates >*1,200 g:* 50,000 units/kg IM once. Children: 300,000–1.2 million units/kg q 3–4 wk IM (max: 1.2–2.4 million units/dose). Adults: 1.2 million units IM q 3–4 wk.	*Cautions:* β-Lactam safety profile (rash, eosinophilia), allergy. Administer by IM injection only. Substantial pathogen resistance. Primarily renally eliminated. *Drug interaction:* Probenecid.
Penicillin G, procaine Crysticillin. Injection.	**Repository form of penicillin providing low penicillin concentrations for 12 hr.** Neonates >1,200 g: 50,000 units/kg/24 hr IM. Children: 25,000–50,000 units/kg/24 hr IM for 10 days (max: 4.8 million units/dose). Gonorrhea: 100,000 units/kg (max: 4.8 million units/24 hr) IM once with probenecid 25 mg/kg (max dose: 1 g) Adults: 0.6–4.8 million units q 12–24 hr IM.	*Cautions:* β-Lactam safety profile (rash, eosinophilia) allergy. Administer by IM injection only. Substantial pathogen resistance. Primarily renally eliminated. *Drug interaction:* Probenecid.
Penicillin V Pen VK, V-Cillin K. Tablet: 125, 250, 500 mg. Suspension: 125 mg/5 mL, 250 mg/5 mL.	**Preferred oral dosing form of penicillin, active against most gram-positive cocci; *S. pneumoniae* (resistance is increasing), other *Streptococcus,* and some gram-negative bacteria (e.g., *N. gonorrhoeae, N. meningitidis*).** Children: 25–50 mg/kg/24 hr divided q 4–8 hr PO. Adults: 125–500 mg q 6–8 hr PO (max dose: 3 g/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia), allergy, seizures with excessive doses particularly in patients with renal disease. Substantial pathogen resistance. Primarily renally eliminated. Inactivated by penicillinase. *Drug interaction:* Probenecid.
Piperacillin Pipracil. Injection.	**Extended-spectrum penicillin active against *E. coli, Enterobacter, Serratia, P. aeruginosa,* and *Bacteroides.*** Neonates: Postnatal age ≤7 days 150 mg/kg/24 hr divided q 8–12 hr IV; >7 days; 200 mg/kg divided q 6–8 hr IV. Children: 200–300 mg/kg/24 hr divided q 4–6 hr IV; cystic fibrosis: 350–500 mg/kg/24 hr IV. Adults: 2–4 g/dose q 4–6 hr (max dose: 24 g/24 hr) IV.	*Cautions:* β-Lactam safety profile (rash, eosinophilia); painful given intramuscularly; each gram contains 1.9 mEq sodium. Interferes with platelet aggregation/serum sickness–like reaction with high doses; increases in liver function tests. Renally eliminated. Inactivated by penicillinase. *Drug interaction:* Probenecid.
Piperacillin-tazobactam Zosyn. Injection.	**Extended-spectrum penicillin (piperacillin) combined with a β-lactamase inhibitor (tazobactam) active against *S. aureus, H. influenzae, E. coli, Enterobacter, Serratia, Acinetobacter, P. aeruginosa,* and *Bacteroides.*** Children: 300–400 mg/kg/24 hr divided q 6–8 hr IV or IM. Adults: 3.375 g q 6–8 hr IV or IM.	*Cautions:* β-Lactam safety profile (rash, eosinophilia); painful given intramuscularly; each gram contains 1.9 mEq sodium. Interferes with platelet aggregation, serum sickness–like reaction with high doses, increases in liver function test results. Renally eliminated. *Drug interaction:* Probenecid.
Quinupristin/dalfopristin Synercid. IV injection: powder for reconstitution, 10 mL contains 150 mg quinupristin, 350 mg dalfopristin.	**Streptogramin antibiotic (quinupristin) active against vancomycin-resistant *E. faecium* (VRE) and methicillin-resistant *S. aureus.* Not active against *E. faecalis.*** Children and adults: VRE: 7.5 mg/kg q 8 hr IV for VRE; skin infections: 7.5 mg/kg q 12 hr IV.	*Adverse events:* Pain, edema, or phlebitis at injection site, nausea, diarrhea. *Drug interactions:* Synercid is a potent inhibitor of CYP3A4.
Sulfadiazine Tablet: 500 mg.	**Sulfonamide antibiotic primarily indicated for the treatment of lower urinary tract infections due to *E. coli, P. mirabilis,* and *Klebsiella.*** Toxoplasmosis: Neonates: 100 mg/kg/24 hr divided q 12 hr PO with pyrimethamine 1 mg/kg/24 hr PO (with folinic acid). Children: 120–200 mg/kg/24 hr divided q 6 hr PO with pyrimethamine 2 mg/kg/24 hr divided q 12 hr PO ≥3 days then 1 mg/kg/24 hr (max dose: 25 mg/24 hr) with folinic acid. Rheumatic fever prophylaxis: ≤30 kg: 500 mg/24 hr q 24 hr PO; >30 kg: 1 g/24 hr q 24 hr PO.	*Cautions:* Rash, Stevens-Johnson syndrome, nausea, leukopenia, crystalluria. Renal and hepatic elimination; avoid use with renal disease. Half-life ~10 hr. *Drug interactions:* Protein displacement with warfarin, phenytoin, methotrexate.

TABLE 179-3. Antibacterial Medications (Antibiotics)—cont'd

DRUG (TRADE NAMES, FORMULATIONS)	INDICATIONS (MECHANISM OF ACTION) AND DOSING	COMMENTS
Sulfamethoxazole Gantanol Tablet: 500 mg Suspension: 500 mg/5 mL	**Sulfonamide antibiotic used for the treatment of otitis media, chronic bronchitis, and lower urinary tract infections due to susceptible bacteria.** Children: 50–60 mg/kg/24 hr divided q 12 hr PO Adults: 1 g/dose q 12 hr PO (max dose: 3 g/24 hr)	*Cautions:* Rash, Stevens-Johnson syndrome, nausea, leukopenia, crystalluria. Renal and hepatic elimination; avoid use with renal disease. Half-life 12 hr. Initial dose often a loading dose (doubled). *Drug interactions:* Protein displacement with warfarin, phenytoin, methotrexate.
Sulfisoxazole Gantrisin Tablet: 500 mg Suspension: 500 mg/5 mL Ophthalmic solution, ointment	**Sulfonamide antibiotic used for the treatment of otitis media, chronic bronchitis, and lower urinary tract infections due to susceptible bacteria.** Children: 120–150 mg/kg/24 hr divided q 4–6 hr PO (max dose: 6 g/24 hr) Adults: 4–8 g/24 hr divided q 4–6 hr PO	*Cautions:* Rash, Stevens-Johnson syndrome, nausea, leukopenia, crystalluria. Renal and hepatic elimination; avoid use with renal disease. Half-life ~7–12 hr. Initial dose often a loading dose (doubled). Drug interactions: Protein displacement with warfarin, phenytoin, methotrexate.
Ticarcillin Ticar Injection	**Extended-spectrum penicillin active against *E. coli, Enterobacter, Serratia, P. aeruginosa,* and *Bacteroides.*** Neonates: Postnatal age ≤7 days <2,000 g: 150 mg/kg/24 hr divided q 8–12 hr IV; >7 days: <2,000 g: 225 mg/kg/24 hr divided q 8 hr IV; >7 days <1,200 g: 150 mg/kg/24 hr divided q 12 hr IV; 1,200–2,000 g: 225 mg/kg/24 hr divided q 8 hr IV; >2,000 g: 300 mg/kg/24 hr divided q 6–8 hr IV. Children: 200–400 mg/kg/24 hr divided q 4–6 hr IV; cystic fibrosis: 400—600 mg/kg/24 hr IV. Adults: 2–4 g/dose q 4–6 hr IV (max dose: 24 g/24 hr)	*Cautions:* β-Lactam safety profile (rash, eosinophilia); painful given intramuscularly; each gram contains 5–6 mEq sodium. Interferes with platelet aggregation; increases in liver function tests. Renally eliminated. Inactivated by penicillinase. *Drug interaction:* Probenecid.
Ticarcillin-clavulanate Timentin Injection	**Extended-spectrum penicillin (ticarcillin) combined with a β-lactamase inhibitor (clavulanate) active against *S. aureus, H. influenzae, Enterobacter, E. coli, Serratia, P. aeruginosa, Acinetobacter,* and *Bacteroides.*** Children: 280–400 mg/kg/24 hr q 4–8 hr IV or IM. Adults: 3.1 g q 4–8 hr IV or IM (max dose: 18–24 g/24 hr).	*Cautions:* β-Lactam safety profile (rash, eosinophilia); painful given intramuscularly; each gram contains 5–6 mEq sodium. Interferes with platelet aggregation; increases in liver function tests. Renally eliminated. *Drug interaction:* Probenecid.
Tobramycin Nebcin, Tobrex Injection Ophthalmic solution, ointment	**Aminoglycoside antibiotic active against gram-negative bacilli, especially *E. coli, Klebsiella, Enterobacter, Serratia, Proteus,* and *Pseudomonas.*** Neonates: Postnatal age ≤7 days, 1,200–2,000 g: 2.5 mg/kg q 12–18 hr IV or IM; >2,000 g: 2.5 mg/kg q 12 hr IV or IM; postnatal age >7 days, 1,200–2,000 g: 2.5 mg/kg q 8–12 hr IV or IM; >2,000 g: 2.5 mg/kg q 8 hr IV or IM. Children: 2.5 mg/kg/24 hr divided q 8–12 hr IV or IM. Alternatively may administer 5–7.5 mg/kg/24 hr IV. Preservative-free preparation for intraventricular or intrathecal use: neonate: 1 mg/24 hr; children: 1–2 mg/24 hr; adults: 4–8 mg/24 hr. Adults: 3–6 mg/kg/24 hr divided q 8 hr IV or IM.	*Cautions: S. pneumoniae,* other *Streptococcus,* and anaerobes are resistant. May cause ototoxicity and nephrotoxicity. Monitor renal function. Drug eliminated renally. Administered IV over 30–60 min. *Drug interactions:* May potentiate other ototoxic and nephrotoxic drugs. *Target serum concentrations:* Peak 6–12 mg/L; trough <2 mg/L.
Trimethoprim Proloprim, Trimpex Tablet: 100, 200 mg	**Folic acid antagonist effective in the prophylaxis and treatment of *E. coli, Klebsiella, Proteus mirabilis,* and *Enterobacter* urinary tract infections; *P. carinii* pneumonia.** Children: For urinary tract infection: 4–6 mg/kg/24 hr divided q 12 hr PO. Children >*12 yr and adults:* 100–200 mg q 12 hr PO. *P. carinii* pneumonia (with dapsone): 15–20 mg/kg/24 hr divided q 6 hr for 21 days PO.	*Cautions:* Megaloblastic anemia, bone marrow suppression, nausea, epigastric distress, rash. *Durg interactions:* Possible interactions with phenytoin, cyclosporine, rifampin, warfarin.
Vancomycin Vancocin, Luphocin Injection Capsule: 125 mg, 250 mg Suspension	**Glycopeptide antibiotic active against most gram-positive pathogens including *Staphylococcus* (including methicillin-resistant *S. aureus* and coagulase-negative staphylococci), *S. pneumoniae* including penicillin-resistant strains, *Enterococcus* (resistance is increasing), and *Clostridium difficile*-associated colitis.** Neonates: Postnatal age ≤7 days, <1,200 g: 15 mg/kg/24 hr divided q 24 hr IV; 1,200–2,000 g: 15 mg/kg/24 hr divided q 12–18 hr IV; >2,000 g: 30 mg/kg/24 hr divided q 12 hr IV; postnatal age >7 days, <1,200 g: 15 mg/kg/24 hr divided q 24 hr IV; 1,200–2,000 g: 15 mg/kg/24 hr divided q 8–12 hr IV; >2,000 g: 45 mg/kg/24 hr divided q 8 hr IV. Children: 45–60 mg/kg/24 hr divided q 8–12 hr IV; *Clostridium difficile*-associated colitis; 40–50 mg/kg/24 hr divided q 6–8 hr PO. Adults: 0.5–1 g IV q 12 hr IV.	*Cautions:* Ototoxicity and nephrotoxicity particularly when co-administered with other ototoxic and nephrotoxic drugs. Infuse IV over 45–60 min. Flushing (red-man syndrome) associated with rapid IV infusions, fever, chills, phlebitis (central line is preferred). Renally eliminated. *Target serum concentrations:* Peak (1 hr after 1 hr infusion) 30–40 mg/L; trough 5–10 mg/L.

(carbenicillin, ticarcillin) and **ureidopenicillins** (piperacillin, mezlocillin, azlocillin) also have bactericidal activity against most strains of *P. aeruginosa*.

Resistance to penicillin is mediated by a variety of mechanisms (see Table 179-1). The production of β-lactamase is a common mechanism exhibited by many organisms that may be overcome, with variable success, by including a β-lactamase inhibitor with the penicillin. These combination products (ampicillin-sulbactam, amoxicillin-clavulanate, piperacillin-tazobactam) are very useful for management of resistant isolates if the resistance is β-lactamase mediated. Notably, *S. aureus* and *S. pneumoniae* mediate β-lactam resistance through mechanisms other than β-lactamase production, rendering these combination agents of little value for the management of these infections.

Adverse reactions to penicillins are noted in Table 179-4.

Cephalosporins. Cephalosporins differ structurally from penicillins by having the β-lactam ring as a 6 member ring, compared to the 5 member ring structure of the penicillins. These agents are widely used in pediatric practice, both in oral and parenteral formulations (Table 179-5). The **1st generation cephalosporins** (cefazolin, a parenteral formulation, and cephalexin, an oral equivalent) are commonly used for management of skin and soft tissue infections caused by susceptible strains of *S. aureus* and group A streptococcus. The **2nd generation cephalosporins**

TABLE 179-4. Adverse Reactions to Penicillins*

TYPE OF REACTION	FREQUENCY (%)	OCCURS MOST FREQUENTLY WITH*
ALLERGIC		
IgE antibody	0.004–0.4	Penicillin G
Anaphylaxis		
Early urticaria (<72 h)		
Cytotoxic antibody	Rare	Penicillin G
Hemolytic anemia		
Antigen-antibody complex disease	Rare	Penicillin G
Serum sickness		
Delayed hypersensitivity	4–8	Ampicillin
Contact dermatitis		
IDIOPATHIC	4–8	Ampicillin
Skin rash		
Fever		
Late-onset urticaria		
GASTROINTESTINAL	2–5	
Diarrhea	2–5	Ampicillin
Enterocolitis	<1	Ampicillin
HEMATOLOGIC		
Hemolytic anemia	Rare	Penicillin G
Neutropenia	1–4	Penicillin G, nafcillin, oxacillin, piperacillin
Platelet dysfunction	3	Carbenicillin, ticarcillin
HEPATIC		
Elevated serum aspartate transaminase level	1–4	Oxacillin, nafcillin, carbenicillin
ELECTROLYTE DISTURBANCE		
Sodium overload	Variable	Ticarcillin
Hypokalemia	Variable	Ticarcillin
Hyperkalemia—acute	Rare	Penicillin G
NEUROLOGIC		
Seizures	Rare	Penicillin G
Bizarre sensations		Procaine penicillin
RENAL		
Interstitial nephritis	1–2	Methicillin
Hemorrhagic cystitis	Rare	Methicillin

*All the reactions can occur with any of the penicillins.
From Mandell GL, Bennett JE, Dolin R (editors): *Principles and Practice of Infectious Diseases*, 6th ed, Vol 1, Philadelphia, Elsevier, 2005, p 286.

TABLE 179-6. Potential Adverse Effects of Cephalosporins

TYPE	SPECIFIC	FREQUENCY
Hypersensitivity	Rash	1–3%
	Urticaria	<1%
	Serum sickness	<1%
	Anaphylaxis	0.01%
Gastrointestinal		
	Diarrhea	1–19%
	Nausea, vomiting	1–6%
	Transient transaminase elevation	1–7%
	Biliary sludge	20–46%*
Hematologic		
	Eosinophilia	1–10%
	Neutropenia	<1%
	Thrombocytopenia	<1–3%
	Hypoprothrombinemia	<1%
	Impaired platelet aggregation	<1%
	Hemolytic anemia	<1%
Renal		
	Interstitial nephritis	<1%
Central nervous system		
	Seizures	<1%
False-positive laboratory		
	Coombs positive	3%
	Glucosuria	Rare
	Serum creatinine	Rare
Other		
	Drug fever	Rare
	Disulfiram-like reaction†	Rare
	Superinfection	Rare
	Phlebitis	Rare

*Ceftriaxone.
†Cephalosporins with thiomethyl tetrazole ring (MTT) side chain.
From Mandell GL, Bennett JE, Dolin R (editors): *Principles and Practice of Infectious Diseases*, 6th ed, Vol 1, Philadelphia, Elsevier, 2005, p 303.

(cefuroxime, cefoxitin) have better activity against gram-negative infections than do 1st generation cephalosporins and are used to treat respiratory tract infections, urinary tract infections, and soft-tissue infections. A variety of orally administered 2nd generation agents (cefaclor, cefprozil, loracarbef, cefpodoxime) are commonly used in the outpatient management of sinopulmonary infections. The **3rd generation cephalosporins** (cefotaxime, ceftriaxone, and ceftazidime) are used for serious pediatric infections, including meningitis and sepsis. Ceftazidime is highly active against most strains of *P. aeruginosa*, making this a useful agent for febrile, neutropenic oncology patients. Another class of **4th generation cephalosporins** (cefepime) is indicated for treatment of pediatric meningitis, has activity against *P. aeruginosa*, and retains good activity against methicillin-susceptible staphylococcal infections.

Adverse reactions to cephalosporins are noted in Table 179-6.

Carbapenems. The carbapenems include imipenem, which is a combination of thienamycin and cilastatin, and the newer agents, meropenem and ertapenem. The basic structure of these agents is similar to that of β-lactam antibiotics, with a similar mechanism of action. The carbapenems provide the broadest spectrum of antibacterial activity of any licensed class of antibiotics, and are active against gram-positive, gram-negative, and anaerobic organisms. Meropenem is licensed for treatment of pediatric meningitis. MRSA and *Enterococcus faecium* are not susceptible to carbapenems. Carbapenems also tend to be poorly active against *Stenotrophomonas maltophilia*, rendering their use for cystic fibrosis patients colonized with this organism problematic.

TABLE 179-5. Classification of Parenteral and Oral Cephalosporins

CEPHALOSPORINS	1ST GENERATION	2ND GENERATION	CEPHAMYCINS	3RD GENERATION	4TH GENERATION
Parenteral	Cefazolin (Ancef, Kefzol)	Cefamandole (Mandol)	Cefmetazole (Zefazone)	Cefoperazole (Cefobid)	Cefepime (Maxipime)
	Cephalothin (Keflin, Seffin)	Cefonicid (Monocid)	Cefotetan (Cefotan)	Cefotaxime (Claforan)	Cefpirome
	Cephapirin (Cefadyl)	Cefuroxime (Kefurox, Zinacef)	Cefoxitin (Mefoxin)	Ceftazidime (Fortaz)	
	Cephradine (Velosef)			Ceftizoxime (Cefizox)	
				Ceftriaxone (Rocephin)	
Oral	Cefadroxil (Duricef, Ultracef)	Cefaclor (Ceclor)		Cefdinir (Omnicef)	
	Cephalexin (Keflex, Biocef, Keftab)	Cefprozil (Cefzil)		Cefditoren (Spectracef)	
	Cephradine (Velosef)	Cefuroxime-axetil (Ceftin)		Cefixime (Suprax)	
		Loracarbef (Lorabid)		Cefpodoxime (Vantin)	
				Ceftibuten (Cedax)	

From Mandell GL, Bennett JE, Dolin R (editors): *Principles and Practice of Infectious Diseases*, 6th ed, Vol 1, Philadelphia, Elsevier, 2005, p 297.